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Research Article

Factors Affecting Personal Hearing Protector (PHP) Use Among Industrial Workers: Development and Validation of the Questionnaire

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ABSTRACT

Personal hearing protectors (PHPs) used by industrial workers have already been a preferred measure in various industrial sectors that have issues with excessive noise exposure. Although personal hearing protectors (PHPs) are widely provided across industrial workplaces, actual worker compliance with their consistent and correct use remains notably low. Therefore, this study aimed to develop a valid measure to evaluate factors affecting PHP use among industrial workers in Malaysia. A questionnaire was developed on the factors affecting PHP use among industrial workers in Malaysia. The questionnaire comprised several items and was created using a systematic, thorough process consisting of three stages: (i) formulating items, (ii) translating them back-to-back, and (iii) subjecting them to expert content assessment by six (6) panels of experts. The questionnaire constructs and items were evaluated for content validity and reliability. The content validity score for each item was considered satisfactory. The Cronbach's alpha was 0.940, indicating high overall internal consistency. The domain coefficients were as follows: interpersonal influence, 0.899; perceived severity, 0.902; perceived benefit, 0.868; perceived barrier, 0.893; perceived self-efficacy, 0.879; cues to action, 0.815; and use of PHP, 0.840. The domain coefficients demonstrated good to high internal consistency, ranging from 0.815 (cues to action) to 0.902 (perceived severity). This study shows that the questionnaire on factors affecting PHP use among industrial workers is valid and well-structured. Therefore, this study provides a valid and reliable tool for assessing factors influencing PHP use, which can inform the planning of targeted noise management programs.

Keywords: personal hearing protectors (PHP), industrial workers, noise exposure, questionnaire development

INTRODUCTION

The World Health Organization (WHO) estimated that approximately 466 million individuals worldwide have hearing loss [1]. Rapid industrialization, particularly in developing countries, has increased the risk of workplace noise-related diseases [2]. Across emerging and industrialized nations, the prevalence of work-related hearing impairment remains a problem due to excessive noise emissions from machinery, work processes, job duties, or combinations of these emissions, if these emissions are not well managed [2]. Kee et al. [3] found a link between the levels of personal noise exposure of construction workers and the occurrence of psychological health consequences symptoms among machine operators. In 2011, Malaysia saw an increase in noise-induced hearing loss (NIHL) cases in some manufacturing businesses in Johor, Pahang, Pulau Pinang, Selangor, and Terengganu [4]. The statistics from the Department of Statistics Malaysia [5] indicate that noise-related hearing disorders constitute the highest number of cases among the occupational disease categories. The rise in these cases began in 2015 [6].

To reduce these risks, a hierarchy of hazard controls may be implemented, including removal of the source of noise (if possible), technical control and the administration or issuing of personal protective equipment [7]. The first line of defense in the fight to minimize NIHL is the Hearing Protection Programme (HCP), which emphasises the reduction of noise through technical and administrative measures [7]. Engineering control measures include several techniques such as absorption, isolation, dampening, silencing and vibration isolation. Such measures should be assessed by considering the appropriate techniques, their use and effectiveness, and the maintenance of the equipment. Administrative control should be applied where exposure to noise cannot be reduced by technical noise control measures. Although technical and administrative measures are very effective in reducing noise production by workers and exposure of individuals, their implementation often presents major challenges [8], [9]. Where it is not possible to reduce the unjustified noise level by technical or administrative measures, the employer must take more appropriate measures to mitigate the risk, such as the use of a personal hearing protection (PHP) [10], [11]. If noise levels cannot be eliminated or reduced by other means, PAF, such as earplugs and headphones, are indispensable for protecting workers from excessive noise [12].

However, studies in various sectors in Malaysia, including manufacturing, quarrying and sawing, show an alarmingly low level of personal hearing protection (PHP), often below 40 percent and sometimes even in the single digits [13] [14]. For example, Ndep et al. [16] found that only 22.2% of factory workers consistently used protective equipment. Similarly, research in various industrial settings has shown particularly low use rates of earplug: Rus et al. [17] reported only 9.6 percent of consistent use among sawmill workers, while Ishak et al. [18] found only a moderate level of compliance with the PHP among landfill site workers. This lack of compliance has serious consequences; Akbar-Khanzadeh et al. [19] estimate that 12-14% of all occupational injuries resulting in permanent disability are attributed to workers who do not wear adequate PPE. Therefore, the consistent use of PHP by industrial workers is essential to mitigate the significant risks to the health of hearing [20].

The behavior of industrial workers in wearing PHP is influenced by various factors [21]. In the Malaysian context, it is important to note that according to previous researchers, it has been estimated that between 2 million and 5.5 million documented and undocumented migrant workers live in Malaysia, working primarily in six economic sectors such as manufacturing, construction, agriculture, plantation, services and domestic work [22], [23]. Despite immigrants' willingness to work long hours [22], [24], a study by Shankar et al. [25] found that newly hired immigrants' knowledge of occupational health and safety is still lacking. This lack of knowledge, combined with poor training, limited support, workplace power imbalances, and a weak safety culture, makes it challenging for migrant workers to obtain occupational health and safety information and execute safe work practices, such as wearing PPE, in many companies [25].

When a workplace has issues with excessive noise exposure, the provision of PHP by the employer to its employees is a mandatory regulation [26]. Yet, Nyarubeli et al. [27] found that although PHP was made available, its use was extremely low and NIHL was prevalent, indicating the possibility of behavioral and cultural divide (attitudes and beliefs) that had influenced the desired behavior, i.e., inconsistent use of PHP. Therefore, in handling and addressing human behavior and the multi-cultural population among industrial workers, it is essential to find the root cause of effective solutions and foster a positive work environment. According to Sam et al. [15], employers have continued to favor the use of PHP as a preventative measure, and significant human-factor elements were found to be crucial in maintaining the consistency of workers wearing personal hearing protectors. Supporting this, Fauzan et al. [21] explored that sociodemographic, interpersonal, situational, and health-promoting behavior are the key determinants of workers' PHP usage in various industries, such as the construction and manufacturing industries.

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Given this complex behavioral landscape, theoretical guidance is essential for understanding the multifaceted factors that influence workers' behavior regarding hearing protection. The Health Promotion Model, Health Belief Model, Theory of Planned Behavior, and Theory of Reasoned Action are best utilized in predicting an individual's behavior in relation to using hearing protection devices at the workplace. These models have also been used to guide the application of PHP interventions at work [32]. For instance, Hong et al. [33] used the Health Promotion Model, Social Cognitive Theory, and Health Belief Model to identify the predictors of PHP use among firefighters. The goal of each model is to provide the best tool to forecast whether a worker would use a PHP while working in a noisy environment, which will enable the workplace to construct and implement effective PHP use interventions [32], [34]. To develop such useful tools, it is essential to have a mix of knowledge and abilities to understand the working environment and employees' attitudes, experiences, and perceptions related to the use of PHP [27].

The health promotion model highlights in particular the individual characteristics, perceived benefits and barriers, self-efficacy and situational effects that shape health-related activities. The health belief model, on the other hand, focuses on perceived sensitivity, perceived severity, cues to action and health motivation to predict protective behavior. However, it should be noted that the revised health promotion model and the health belief model did not attract significant interest from researchers to study workers in the Malaysian manufacturing sector.

Therefore, an appropriate instrument should be developed combining two theoretical models - the Health Promotion Model [35] and the Health Belief Model [36] - to address the relevant human factors for workers in the Malaysian manufacturing sector. This need is further underlined by the review of the existing instruments which has highlighted some important shortcomings which limit their applicability to the Malaysian industry. First, many of the tools available lack cultural and contextual relevance, having been developed in specific sectors or regions and not necessarily reflecting the different working practices, organizational cultures and behavioral norms that exist in different workplaces [27]. For example, on the one hand, Nyarubeli et al. [27] developed a questionnaire tool aimed at predicting PHP use among manufacturing factory workers in Tanzania, which included relevant cognitive constructs and population characteristics regarding the use of PHP.

On the other hand, a survey instrument was developed by Neitzel et al. [28] and mapped to the constructs of the theoretical model used to develop the training and evaluate long-term PHP use among construction workers. Furthermore, there is another tool named the hearing beliefs questionnaire (HBQ) and its associations with hearing health behavior [29]; however, this tool only focuses on respondents who wear hearing aids. Another questionnaire on predictors of hearing protection use among industrial workers was developed by Tantranont and Codchanak [30]. This tool was adapted to the Predictors of Use Hearing Protector Model (PUHPM) by Hong et al. [31] and covers several factors, such as modifying and cognitive-perceptual factors. The modifying factors included demographic/experiential factors, interpersonal influence, and situational factors affecting PHPs usage. Besides, the cognitive-perceptual factors included perceived benefit, perceived barriers, perceived self-efficacy, perceived susceptibility, and perceived severity. However, the strong factors applied in this tool, like perceived benefits, perceived barriers, and self-efficacy in the use of PHP unable to predict the usage among workers. Thus, earlier authors emphasize that the results could have been affected by various sample characteristics and instruments [30]. In addition, this instrument targets industrial workers from 15 production plants in Thailand. Taken together, these limitations underline the need for a context-specific, comprehensive and theoretically robust instrument which can assess accurately the determinants of the use of personal hearing protection (PHP) by industrial workers in Malaysia and thus provide a basis for targeted interventions.

The aim of this study is therefore to develop and validate a new questionnaire based on a combined health promotion and health belief model framework to identify key predictors of the use of PHP in noise-sensitive industrial workers in Malaysia. A pilot study has been carried out to ensure that the questionnaire questions are understood by the target respondents. The new instrument proposed must be suitable for use and can be used to understand the factors influencing the use of PHP by workers in the Malaysian manufacturing industry. This tool can therefore be used by industrial staff to anticipate the use of PHPs and can help to plan any noise management programme at the workplace. Finally, the development of a new questionnaire needs to be validated to render it suitable for a targeted group of industrial workers.

METHODS

Questionnaire development

Figure 1 illustrates the development process of the validated questionnaire for personal hearing protectors used among workers in the manufacturing industry. The process of questionnaire development was covered in three (3) steps: (1) Development of initial constructs & items in the questionnaire, (2) Questionnaire screening and 2nd Content Validation, and (3) Validity and Reliability testing.

Development of initial constructs and items

The researchers considered items addressing factors influencing the utilization of hearing protection devices by employees in the manufacturing sector. For this purpose, a systematic literature review (SLR) was conducted to identify pertinent articles and existing survey instruments. The online search engines visited included Web of Science (WOS), Science Direct, Scopus, Wiley Online Library, PubMed, and supplementary databases, such as Google

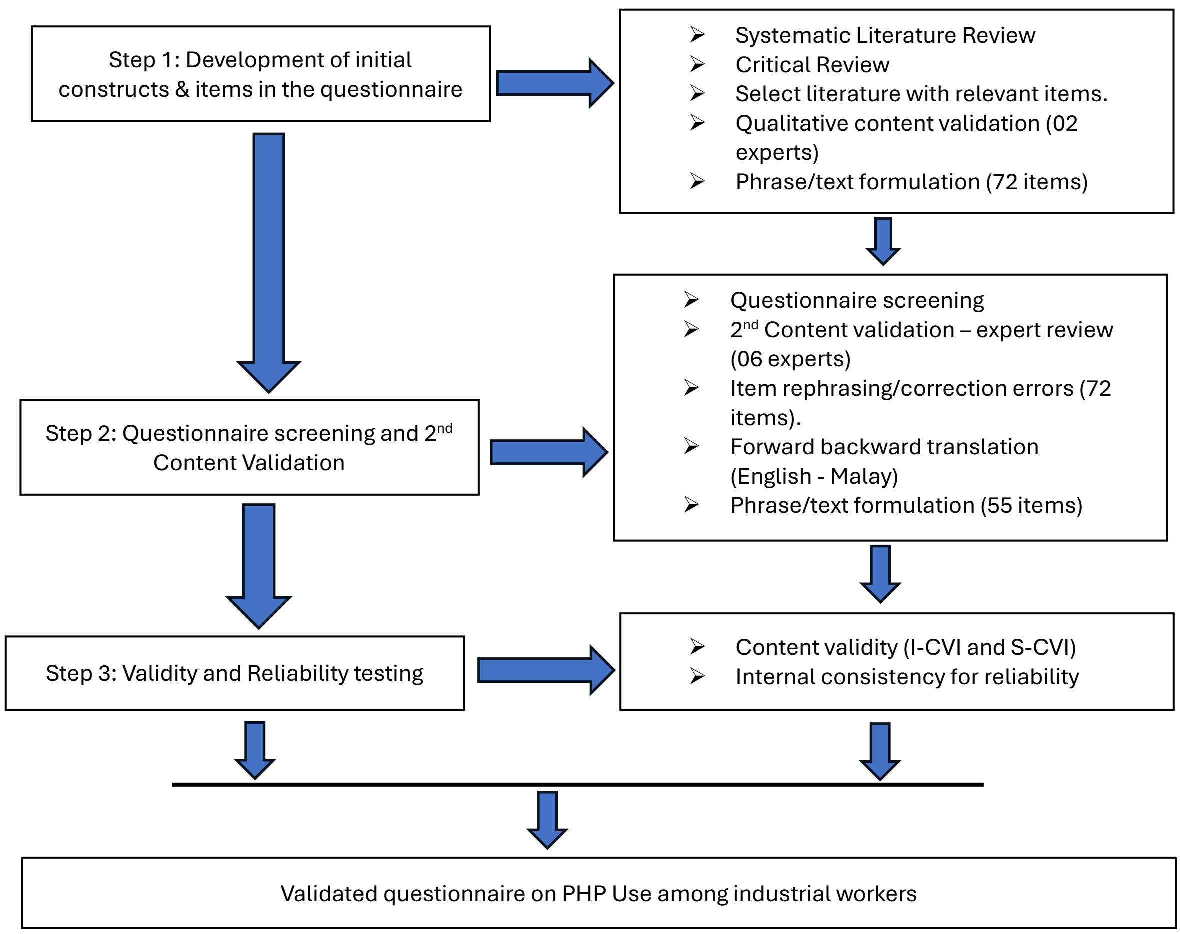

Figure 1. Stepwise procedure for developing the PHP Use questionnaire for industrial workers.

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Scholar. The thematic analysis led to the identification of the seven (7) constructs, which are interpersonal influences, perceived severity, perceived benefit, perceived barriers, perceived self-efficacy, cues to action, and PHP use. The important factors influencing PHP use are summarized based on published articles.

Retrieved from the review. The critical literature review was conducted on the twenty-two (22) selected articles from the SLR. Based on the selected articles, thirteen (13) articles used the theoretical framework to measure the factors associated with personal hearing protectors used among industrial workers. Most of the chosen articles used two established theoretical models, the Health Promotion Model [35] and the Health Belief Model [36], as references to develop the proposed model for determining the key factors influencing the personal hearing protector (PHP) used among industrial workers.

This study combined the Health Promotion Model by Pender [35] and the Health Belief Model [36] to explain the predictors of health-related behavior toward PHP use in an excessively noisy workplace. This integration was also based on the three key principles for behavior change: (i) personal attributes and experiences, including the socio-demographic criteria and interpersonal influences; (ii) cognitions and emotions specific to the behavior, like perceived self-efficacy, susceptibility, benefits, barriers, and cues to the action for using PHP; and (iii) the anticipated outcome of the behavior, which entailed constant and effective utilization of PHP in the workplace.

The combined models produced seven (7) constructs: interpersonal influences, perceived severity, perceived benefit, perceived barriers, perceived self-efficacy, cues to action, and PHP use [35], [36]. Considering these factors, the researcher developed questionnaires to address the determinants of PHP use among noise-exposed workers. The questionnaire included specific personal (changing) predictors that have been identified as influential in the utilization of PHP by industrial employees [37]–[40]. These factors encompass demographic factors that constitute a distinct dimension. The goal was to facilitate the gathering of fundamental data regarding each employee and their work surroundings using the questionnaire. The items were gender, age, marital status, work experience, educational level, nationality, working position, health status, experience of hearing re-examination, experience of illnesses, and type of PHP used at the workplace. The items in each construct were adapted from previous studies. A five-point Likert scale (psychometric scale) ranging from *strongly disagree* to *strongly agree was* used for the systematic evaluation of reliability and validity.

Questionnaire screening and Content Validation

The questionnaire undertook detailed screening and a second round of expert content validation involving six subject-matter experts. Reviews from experts assess the degree to which questionnaire items accurately represent the entire area that should be studied [41]–[43]. For an instrument to have sufficient control over chance agreement, a minimum of five people was proposed as mentioned by Zamanzadeh et al. [44]. Content validity was determined based on the input of a panel of experts. The total number of experts (n = 6) was deemed sufficient for this purpose, as the number of raters often fell within a range of 3 to 10 [44], [45]. At this stage, experts evaluated relevance, clarity, and appropriateness of each item.

The selected experts were practitioners and academics. The practitioners were selected from those with vast experience in the occupational safety and health field and experts in occupational noise. The panel consisted of three academicians specializing in occupational safety and health, an expert in occupational noise, a practitioner with field experience, and a psychometrician. The selected expert panel was provided sufficient time to study and reach consensus on the overall relevance of the constructs to guarantee the comprehensiveness of the tool. Corrections were made to resolve phrasing issues and eliminate redundancy. Following the questionnaire refinements, the item set was reduced to from 72 to 55 items representing clearer and more precise constructs.

Questionnaire translation

The translation process followed a standard forward-backward procedure. The original questionnaire was written in English. However, the target population consisted of employees employed in Malaysia's manufacturing sector. The forward translation into Malay was performed by a native Malay speaker fluent in English with experience in academic and occupational safety and health-related translation. Consequently, Bahasa Malaysia was used to translate the questionnaire before it was retranslated into English. The bilingual researcher, who was not involved in the initial translation, completed the back-translation [27]. The independent back-translation provided an additional check on the semantic equivalence of the translation [46].

Pilot study

A pilot study was carried out with a sample of 50 factory employees. As suggested by Cooper and Schindler [47], a sample size of 25-100 people was considered ideal for pilot test. A sample size of more than 30 guarantees reliable outcomes [48]. The factory's working environment closely resembles the conditions intended for the planned study. Respondents among industrial workers exposed to noise levels above 82dB (A) were chosen.

A total of 50 employees were chosen for convenience sampling, and all agreed to participate. The pilot questionnaire was administered on-site in a designated meeting room to ensure minimal disruption to work activities. The participants were provided with a clear explanation of the aim of the pilot test and were guaranteed that the acquired information would be kept confidential. All participation was voluntary, and strict measures were taken to preserve participants' anonymity and confidentiality throughout the process. Demographic data, including age, marital status, work experience, academic level, nationality, career position, health status, history of hearing re-examination, history of illnesses, and type of PHP worn at the workplace, were gathered.

Statistical analysis

Microsoft Excel was used to evaluate the data obtained from the process of expert review of the questionnaire formulation. Subsequently, the assessment of the questionnaire's reliability and the process of the pilot test were conducted using the Statistical Package for Social Sciences (SPSS). The Likert-scale responses were encoded and assigned numerical values ranging from 1 (*strongly disagree*) to 5 (*strongly agree*) and 1 (*never*) to 5 (*always*). The negative statement questions were reversed before proceeding with the analysis.

Content validity

The quantitative content validity was conducted for the developed questionnaire. The content validity index (CVI) was calculated to analyze the adequacy of the items in each domain/construct [49], [50] and support the validity of the assessment tool [51]. In addition, the CVI is the predominant method used to assess content validity in the construction of tools. The item-CVI (I-CVI) and scale-level-CVI (S-CVI) can be utilized in the computation [44].

Scores were obtained from the six appointed expert panels. During the evaluation, each expert panel evaluated the content and rated each item from each domain/construct based on the relevancy criteria [44]. The relevancy criteria consisted of four scales (1 = *not relevant*, 2 = *somewhat relevant*, 3 = *quite relevant*, and 4 = *highly relevant*). As seen in Table 1, the I-CVI was calculated by dividing the number of experts who rated each item as "*very relevant*" by the total number of experts. Before computing the CVI, the relevance rating was documented as either 1 (indicating a relevance scale of 3 or 4) or 0 (indicating a relevance scale of 1 or 2) [52]. The item was considered relevant when the value was in the range of 0 to 1, where the I-CVI is greater than 0.79. The item required changes if the value fell between 0.70 and 0.79. However, the item is discarded if the value is lower than 0.70 [44]. Subsequently, the S-CVI

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Table 1. Formula for I-CVI and S-CVI/Ave.

The CVI indices	Formula
I-CVI (item-level content validity index)	I-CVI = (agreed item)/(number of experts)
S-CVI/Ave (scale-level content validity index based on the average method)	S-CVI/Ave = (sum of I-CVI scores)/ (number of items)

is computed based on the count of items in an instrument that has obtained a rating of "very relevant" [44]. To calculate the S-CVI, two approaches can be used: the Universal Agreement (UA) among experts (S-CVI/ UA) and Average CVI (S-CVI/Ave) [44]. Microsoft Excel software was used to calculate the CVI.

RESULTS AND DISCUSSION

The primary objective of this research was to establish and initially validate a questionnaire that addresses the factors influencing PHP use among industrial employees in Malaysia. The questionnaire comprised 55 items categorized under seven constructs: interpersonal influence, perceived severity, perceived benefit, perceived barriers, perceived self-efficacy, cues to action, and use of PHP (see Appendix A.1 for details).

The psychometric assessment of the questionnaire from the pilot test yielded satisfactory scores for both content validity and reliability. This indicates that the research tool is suitable for use in surveys intended to assess the utilization of PHP by industrial employees who are open to high levels of noise and are given PHP for work. On the other hand, this new survey tool holds potential utility for researchers aiming to test workers' behavior in wearing the PHP in different sectors in Malaysia. Malaysia country heavily reliant on migrant workers due to a labor shortage [53]. The questionnaire has been designed to reflect the actual working conditions and cultural context of Malaysia's manufacturing industry, making it suitable for application across all sectors in the country. In contrast to the previous study, the previous questionnaire on PHP use was applicable and only tested among industrial workers outside Malaysia countries such as Tanzania [27], Thailand [54] and New Zealand [55]. The variables used in previous tools were tailored to the specific nature and culture of industrial workers in the countries, which significantly differ from the current context of noise-exposed workers in Malaysia.

Content validity of the questionnaire

The screening and refinement process yielded 55 items. The relevance rating of the item scale of the seven domains by the six experts can be found in Appendix A.2. As indicated, most of the I-CVI items recorded a score of 1. However, several items recorded a score of less than 1: three items (II1, II4, II5) under the interpersonal influence domain, four items (PV1, PV2, PV5, PV6) under perceived severity, one item (PB2) under perceived benefit, and one item (PR1) under the perceived barrier. All these items received a score of 0.83 for I-CVI. The response to the content validity primarily addressed grammatical errors, sentence rephrasing, replacement of some confusing words and removing some items due to poor value of validity index. Then, the necessary for double-barrel questions were revised into two separate questions. Accordingly, improvements were made to these items to improve the quality of the sentences. Nevertheless, the I-CVIs solely indicated the items' pertinence to the content construct.

All items demonstrated content validity above the acceptable threshold (Aiken's $V > 0.75$), indicating strong content validity [49]. The Scale-Level Content Validity Index (S-CVI) also reached a satisfactory level with a score exceeding 0.83 [56]. Table 2 summarizes the S-CVI values for each construct: (i) Interpersonal Influence (0.94); (ii) Perceived Severity (0.92); (iii) Perceived Benefit (0.98); (iv) Perceived Barrier (0.98); (v) Perceived Self-efficacy (1); (vi) Cues to action (1); and (vii) Use of PHP (1).

Table 2. The Averaged Scale-level Content Validity Index of Construct

Construct	No. of Items	S-CVI/Ave	Construct	No. of Items	S-CVI/Ave
Interpersonal Influence (II)	8	0.94	Perceived Self-Efficacy (PSE)	10	1
Perceived Severity (PV)	8	0.92	Cues to Action (CA)	8	1
Perceived Benefit (PB)	7	0.98	Use of PHP	5	1
Perceived Barrier (PR)	9	0.98			

According to Polit and Beck [57], a content validity of 0.8 or more for a new tool is deemed acceptable and applicable. It is also recommended that for a scale to be judged as having excellent content validity, it would be constituted by items with I-CVIs that fulfill the criteria of I-CVI=1.00 with 3 to 5 experts and a minimum I-CVI of .78 for 6 to 10 experts [56] and it would have an SCVI/ Ave of .90 or higher [57].

Items from the constructed questionnaire showed satisfactory results on the CVI and S-SCI-Ave indices during the pilot test, indicating excellent content validity. The content validity focused on the relevancy of the items in the questionnaire. The questionnaire was developed using a systematic process that involved a group of experts followed by evidence of relevancy of content validity [58]. The field pilot test step involved targeted respondents with an added reliability aspect of the questionnaire items [27]. Most respondents managed to complete the survey within a time frame of 15 to 20 minutes. This duration, according to Sharma [59], is considered the optimal time to answer a questionnaire.

Demographic characteristics of the pilot test participants

During the pilot test, the questionnaire was administered to 50 industrial workers. All the selected respondents were male, and the majority (72%) were about 25–34 years old. Most workers (98%) were non-Malaysian, while 2% were Malaysian. Then, about seventy-eight percent (78%) of the participants are working as operators, 20% were technician, and 2% were supervisors. Most workers have working experience of approximately two to five years in the industry. All the respondents were provided with PHP and have experience in hearing re-examination (see the details in Appendix A.3).

Questionnaire reliability

The internal consistency of the 55 items in the second-phase questionnaire was assessed using Cronbach's alpha coefficient, which yielded a value of 0.940. Figure 2 shows that all seven domains of the questionnaire scored

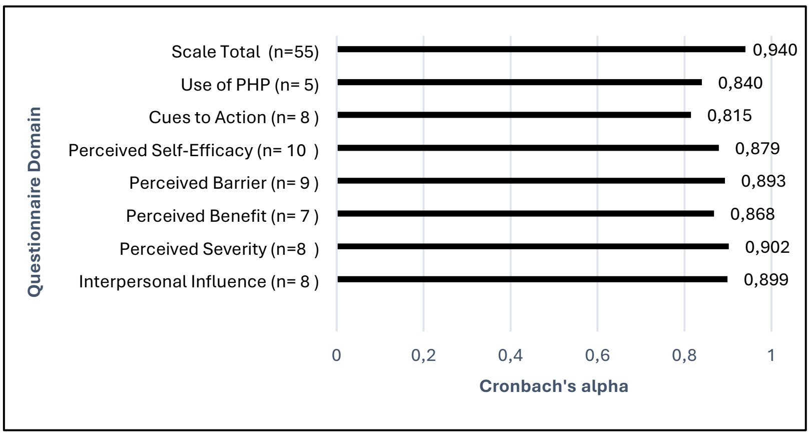

Figure 2. The internal consistency of the items

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satisfactory results in terms of the alpha value. The overall value for Cronbach's alpha was 0.940 with the following domain coefficients: interpersonal influence, 0.899; perceived severity, 0.902; perceived benefit, 0.868; perceived barrier, 0.893; perceived self-efficacy, 0.879; cues to action, 0.815; and use of PHP, 0.840.

CONCLUSION

The primary objective of developing and initially validating a questionnaire was achieved, resulting in a 55-item tool with excellent content validity (S-CVI/Ave > 0.9 for all constructs) and high internal consistency (Cronbach's alpha = 0.94)."This validated questionnaire provides a crucial, context-specific tool for researchers and safety practitioners to better understand and ultimately improve hearing protector use, contributing to the reduction of noise-induced hearing loss in the Malaysian workforce. This study successfully developed and established the content validity and reliability of a new questionnaire designed to assess the factors influencing PHP use among industrial workers in Malaysia. The questionnaire was developed using a systematic, evidence-based strategy, which included a rigorous content validation process to ensure its relevance and appropriateness for the target population. This new questionnaire consists of seven key constructs (e.g., interpersonal influence, perceived severity, perceived benefit, perceived barrier, perceived self-efficacy, cues to action and use of PHP) where the tool is designed to measure, reinforcing the model it was built upon. This tool highlighted the significant factors that potentially influence industrial workers' behaviour in consistently wearing PHP, making it suitable for Malaysia's working environment. Furthermore, the tool can be used to diagnose specific perceptual barriers (e.g., low perceived severity, high perceived barriers) within a workforce, thereby allowing for the design of targeted, and potentially more effective, intervention programs within the Malaysian Hearing Conservation Programme. The development of the survey instrument was tested exclusively in the manufacturing industry. Future research should focus on validating this instrument with a more demographically diverse sample, including female workers and a greater proportion of Malaysian nationals, to strengthen its generalizability within the manufacturing sector. Additionally, cross-industry testing could strengthen the instrument's generalizability, ensuring that it effectively captures a wide range of occupational noise-related perceptions among industrial workers.

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CONFLICTS OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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DATA AVAILABILITY

The data availability statement is not applicable to this study.

ETHICS APPROVAL

Approved by IIUM Research Ethics Committee, No. IREC 2023-141; informed consent obtained from participants.

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APPENDIX

A.1. Questionnaire Item

1) Interpersonal Influence

Item	Description
II1	My team leader often uses personal hearing protector when exposed to a noisy workplace
II2	My co-workers often use personal hearing protector when exposed to a noisy workplace
II3	My co-workers expect me to wear personal hearing protector when I am in a noisy work environment
II4	My family members encourage me to use personal hearing protector when I am in a noisy work environment
II5	My supervisor expects me to wear a personal hearing protector when I am in a noisy work environment regularly
II6	Everyone in the company expect me to wear personal hearing protector regularly
II7	My co-worker expects me to wear personal hearing protector every day.
II8	My company management encourages me to wear personal hearing protector every day.

2) Perceived Severity

Item	Description
PV1	When thinking about the possibility of having hearing loss, I get very worried
PV2	If I developed a hearing loss problem, my career would be in jeopardy
PV3	The problems that I will have to face due to hearing loss will persist for a long period of time
PV4	A hearing loss problem will lead to permanent changes in my health.
PV5	My financial security would be threatened if I developed a hearing loss problem
PV6	I am afraid to even think of the possibility of having hearing loss problems.
PV7	There is no cure for hearing loss problems
PV8	The complications of hearing loss will cause a serious problem to me

3) Perceived Benefit

Item	Description
PB1	I feel safe while wearing a personal hearing protector
PB2	I feel useful while wearing a personal hearing protector
PB3	Wearing a personal hearing protector will prevent future hearing problems for me.
PB4	Personal hearing protector prevents exposure to surrounding noise hazards around me while I am working
PB5	I benefit from wearing a personal hearing protector.
PB6	I think it is important to wear personal hearing protection in a noisy environment
PB7	I am confident that I can prevent hearing loss by wearing personal hearing protection in a noisy environment

4) Perceived Barrier

Item	Description
PR1	Wearing a personal hearing protector makes me uncomfortable.
PR2	A personal hearing protector limits my ability to hear what I want to hear
PR3	I think it will be difficult to hear warning signals (like back-up beeps) if I am wearing hearing protectors
PR4	I don't feel like wearing a personal hearing protector at the workplace
PR5	Personal hearing protectors limit my ability to communicate with others
PR6	I don't like wearing anything on my ears while carrying out job tasks
PR7	I think the personal hearing protector puts too much pressure on my ears
PR8	The personal hearing protector interferes with my ability to carry out my work
PR9	There are disadvantages of wearing personal hearing protectors

5) Perceived Self-Efficacy

Item	Description
PSE1	If wearing personal hearing protectors were comfortable, I would definitely use it
PSE2	I can wear personal hearing protectors regularly at a noisy workplace
PSE3	I wear personal hearing protectors regularly, even though my colleagues around me are not in the habit of wearing personal hearing protector.
PSE4	I am sure about how to know when the personal hearing protector needs to be replaced

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PSE5	I can wear a personal hearing protector properly
PSE6	I can wear a personal hearing protector even while wearing other personal protective equipment (PPE).
PSE7	I am confident that the use of a personal hearing protector can reduce the sounds that my hearing will be exposed to
PSE8	I am confident that I will remember to use a personal hearing protector when I am exposed to noise hazards
PSE9	I am confident that my job performance will not suffer by wearing a personal hearing protector.
PSE10	I am confident that wearing the proper personal hearing protector throughout my career will help prevent me from experiencing hearing loss issues

6) Cues To Action

Item	Description
CA1	Daily reminders from my supervisor are important for me to wear personal hearing protectors
CA2	Inspection from my supervisor will improve my wearing of personal hearing protectors
CA3	Posters at my workplace serve as an important reminder to wear personal hearing protectors
CA4	Having a personal hearing protector at the location of hazard is critical to ensure that I wear it
CA5	If I see others wearing a personal hearing protector in my area, then it reminds me to use it.
CA6	Regular and frequent education on the importance of personal hearing protectors will increase my frequency of wearing it.
CA7	My supervisor shows a good example by wearing a personal hearing protector when exposed to hazards.
CA8	My supervisor provided training about personal hearing protector and the importance of personal hearing protectors is useful.

7) Use Of Personal Hearing Protector (PHP)

Item	Description
UP1	In the past week, how often have you used a personal hearing protector when in excessive noise area?
UP2	In the past month, how often have you used a personal hearing protector when in excessive noise area?
UP3	In the past three months, how often have you used a personal hearing protector when in excessive noise area?
UP4	How often are you aware of compliance with wearing a personal hearing protector when working in an extremely excessive noise area?
UP5	How often do you make sure that your personal hearing protector is fit enough for you?

A.2. The relevance rating on the item scales in by six experts.

Item	Expert agreement (denoted by "√ ")						Total	I-CVI
	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	agreement	
Interpersonal Influence (II)								
II1	√	X	√	√	√	√	5	0.83
II2	√	√	√	√	√	√	6	1
II3	√	√	√	√	√	√	6	1

II4	√	X	√	√	√	√	4	0.83
II5	√	X	√	√	√	√	5	0.83
II6	√	√	√	√	√	√	6	1
II7	√	√	√	√	√	√	6	1
II8	√	√	√	√	√	√	6	1
Average proportion of items							S-CVI/Ave	0.94
Perceived Severity (PV)								
PV1	√	X	√	√	√	√	5	0.83
PV2	√	√	√	X	√	√	5	0.83
PV3	√	√	√	√	√	√	6	1
PV4	√	√	√	√	√	√	6	1
PV5	X	√	√	√	√	√	5	0.83
PV6	√	X	√	√	√	√	5	0.83
PV7	√	√	√	√	√	√	6	1
PV8	√	√	√	√	√	√	6	1
Average proportion of items							S-CVI/Ave	0.92
Perceived Benefit (PB)								
PB1	√	√	√	√	√	√	6	1
PB2	√	√	√	√	√	X	5	0.83
PB3	√	√	√	√	√	√	6	1
PB4	√	√	√	√	√	√	6	1
PB5	√	√	√	√	√	√	6	1
PB6	√	√	√	√	√	√	6	1
PB7	√	√	√	√	√	√	6	1
Average proportion of items							S-CVI/Ave	0.98
Perceived Barrier (PR)								
PR1	√	X	√	√	√	√	5	0.83
PR2	√	√	√	√	√	√	6	1
PR3	√	√	√	√	√	√	6	1
PR4	√	√	√	√	√	√	6	1
PR5	√	√	√	√	√	√	6	1
PR6	√	√	√	√	√	√	6	1
PR7	√	√	√	√	√	√	6	1
PR8	√	√	√	√	√	√	6	1
PR9	√	√	√	√	√	√	6	1
Average proportion of items							S-CVI/Ave	0.98
Perceived Self-Efficacy (PSE)								
PSE1	√	√	√	√	√	√	6	1
PSE2	√	√	√	√	√	√	6	1
PSE3	√	√	√	√	√	√	6	1
PSE4	√	√	√	√	√	√	6	1
PSE5	√	√	√	√	√	√	6	1
PSE6	√	√	√	√	√	√	6	1
PSE7	√	√	√	√	√	√	6	1
PSE8	√	√	√	√	√	√	6	1
PSE9	√	√	√	√	√	√	6	1
PSE10	√	√	√	√	√	√	6	1
Average proportion of items							S-CVI/Ave	1

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Cues to Action (CA)								
CA1	√	√	√	√	√	√	6	1
CA2	√	√	√	√	√	√	6	1
CA3	√	√	√	√	√	√	6	1
CA4	√	√	√	√	√	√	6	1
CA5	√	√	√	√	√	√	6	1
CA6	√	√	√	√	√	√	6	1
CA7	√	√	√	√	√	√	6	1
CA8	√	√	√	√	√	√	6	1
Average proportion of items							S-CVI/Ave	1
Use of PHP								
UP1	√	√	√	√	√	√	6	1
UP2	√	√	√	√	√	√	6	1
UP3	√	√	√	√	√	√	6	1
UP4	√	√	√	√	√	√	6	1
UP5	√	√	√	√	√	√	6	1
Average proportion of items							S-CVI/Ave	1

A.3. Demographic characteristics of pilot test participants (N = 50)

Demographic variables		Frequency (%)
1	**Gender**	
	Male	50 (100)
	Female	0 (0)
2	**Age**	
	≤ 24 years	0 (0)
	25-34 years	36 (72)
	35-44 years	14 (28)
	≥45 years	0 (0)
3	**Nationality**	
	Malaysian	1 (2)
	Non-Malaysian	49 (98)
4	**Marital status**	
	Single	13 (26)
	Married	37 (74)
	Others (widowed, divorced)	0 (0)
5	**Educational level**	
	Primary	30 (60)
	Secondary	16 (32)
	Certificate	4 (8)
	Diploma	0 (0)
	Bachelor's Degree	0 (0)
	Master	0 (0)
	PhD	0 (0)
6.	**Position**	
	Manager	0 (0)
	Executive	0 (0)

	Engineers	0 (0)
	Supervisor	1 (2)
	Technician	10 (20)
	Operator	39 (78)
	General worker	0 (0)
7.	**Working experience**	
	≤ 1 years	0 (0)
	2-5 years	49 (98)
	6-10 years	0 (0)
	≥ 11 years	1 (2)
8.	**Type of Personal Hearing Protector (PHP)**	
	Ear plug	50 (100)
	Ear muff	0 (0)
	Combination	0 (0)
9.	**Job type**	
	Regularly	20 (40)
	Shift	30 (60)
10.	**Do you hear ringing sounds in your ears or different sounds in each ear?**	
	Yes	0 (0)
	No	50 (100)
11.	**Have you had an audiometric test before?**	
	Yes	50 (100)
	No	0 (0)
12.	**Experience of hearing re-examination**	
	Yes	14 (28)
	No	36 (72)
13.	**Are you satisfied with your current personal hearing protector?**	
	Yes	46 (92)
	No	4 (8)
	Not Applicable	0 (0)
14.	**Have you ever had ear surgery or any other major surgery that affected your hearing?**	
	Yes	0 (0)
	No	50 (100)
15.	**Any family history of hearing loss/disorder?**	
	Yes	0 (0)
	No	50 (100)
16	**Have you suffered any illness that has affected your hearing (e.g.: infection, tinnitus, ear discharge, etc.)?**	
	Yes	0 (0)
	No	50 (100)

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